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(54) **SYSTEMS AND METHODS FOR EFFICIENTLY PROCESSING VIRTUAL 3-D DATA**

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See application file for complete search history.

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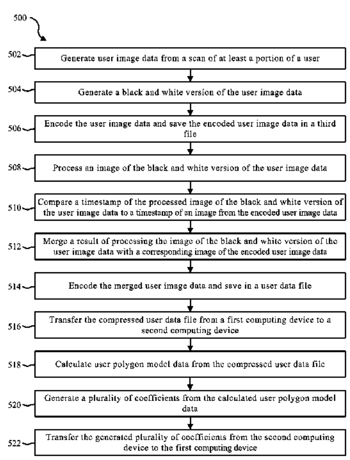
(57) **ABSTRACT**

A computer-implemented method for processing virtual 3-D data efficiently is described. An object image data is generated from a scan of an object. Object polygon model data and object texture map data is generated from the object image data. The object polygon model data is saved in a first object file. The object texture map data is encoded. The encoded object texture map data is saved in a second object file. The data format of the second object file is different than the data format of the first object file.

16 Claims, 8 Drawing Sheets



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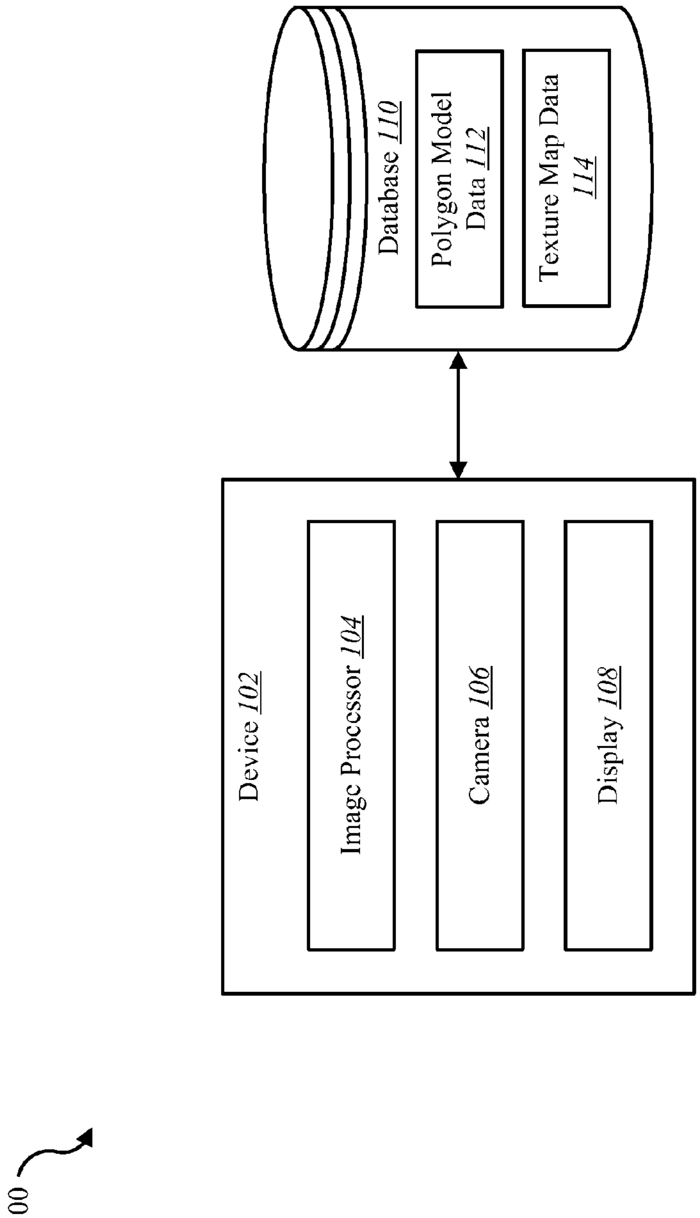

Database 110
Polygon Model Data 112
Texture Map Data 114
Device 102
Image Processor 104
Camera 106
Display 108
100

FIG. 1

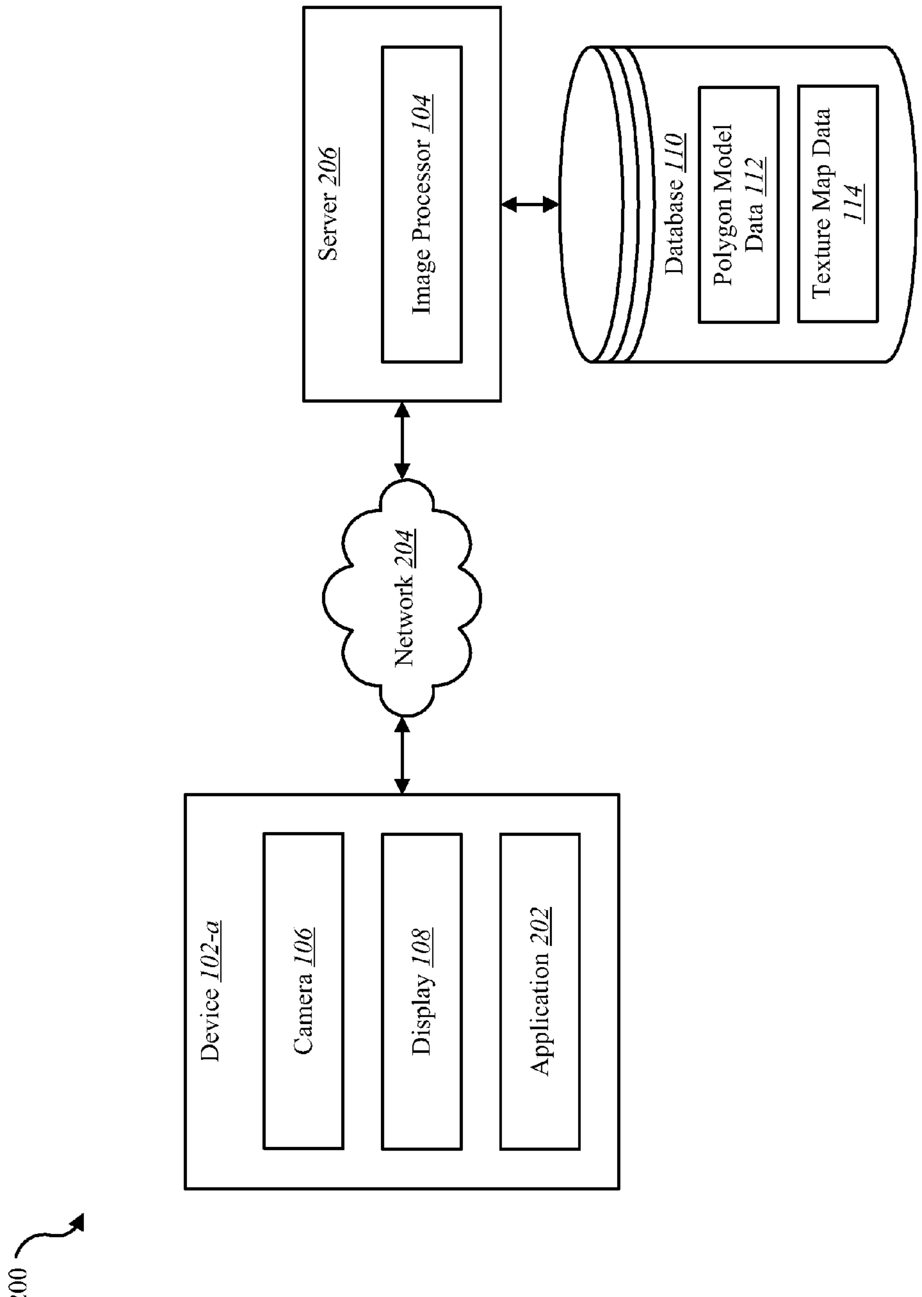

Server 206
Image Processor 104
Database 110
Polygon Model Data 112
Texture Map Data 114
Network 204
Device 102-a
Camera 106
Display 108
Application 202
200

FIG. 2

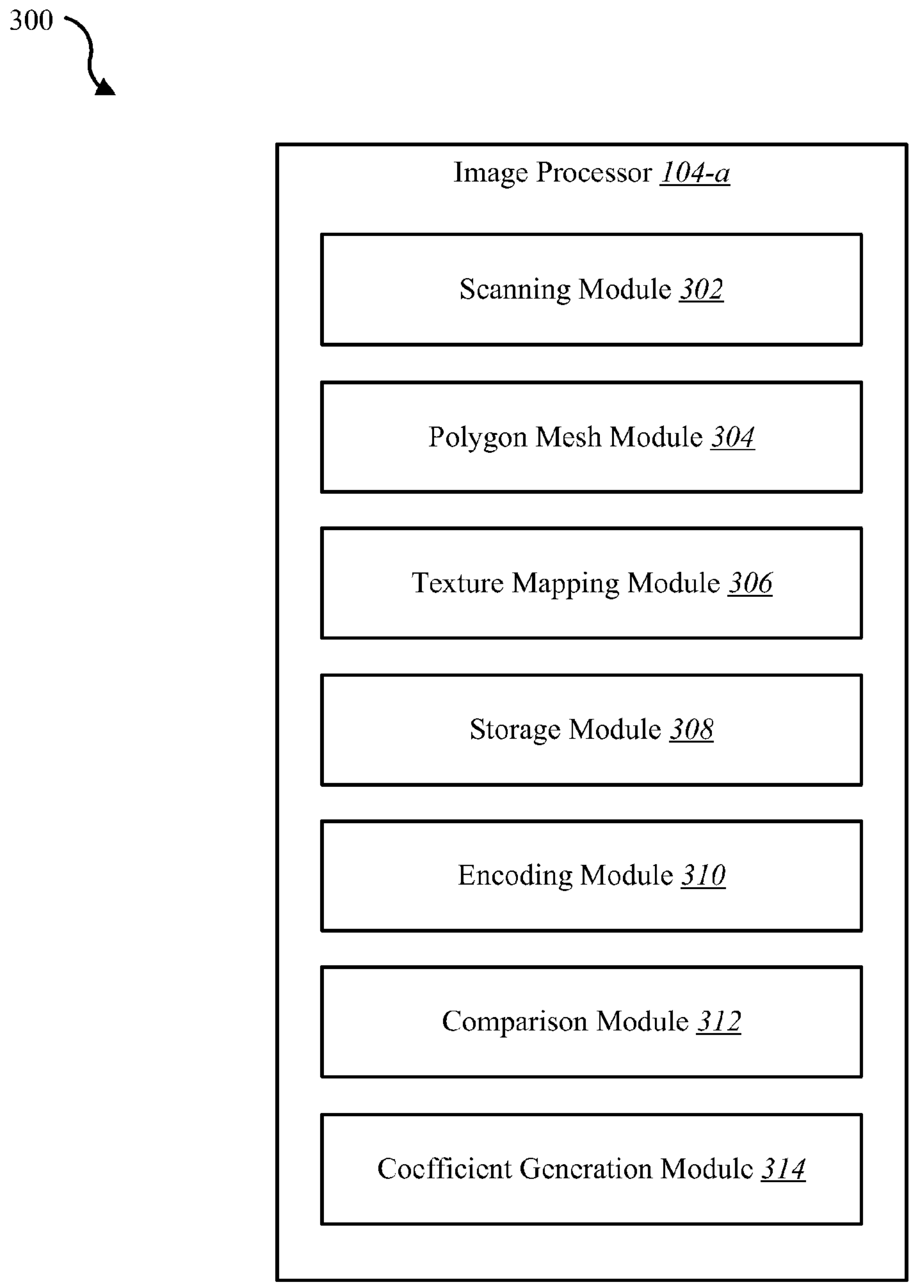

300
Image Processor 104-a
Scanning Module 302
Polygon Mesh Module 304
Texture Mapping Module 306
Storage Module 308
Encoding Module 310
Comparison Module 312
Coefficient Generation Module 314

FIG. 3

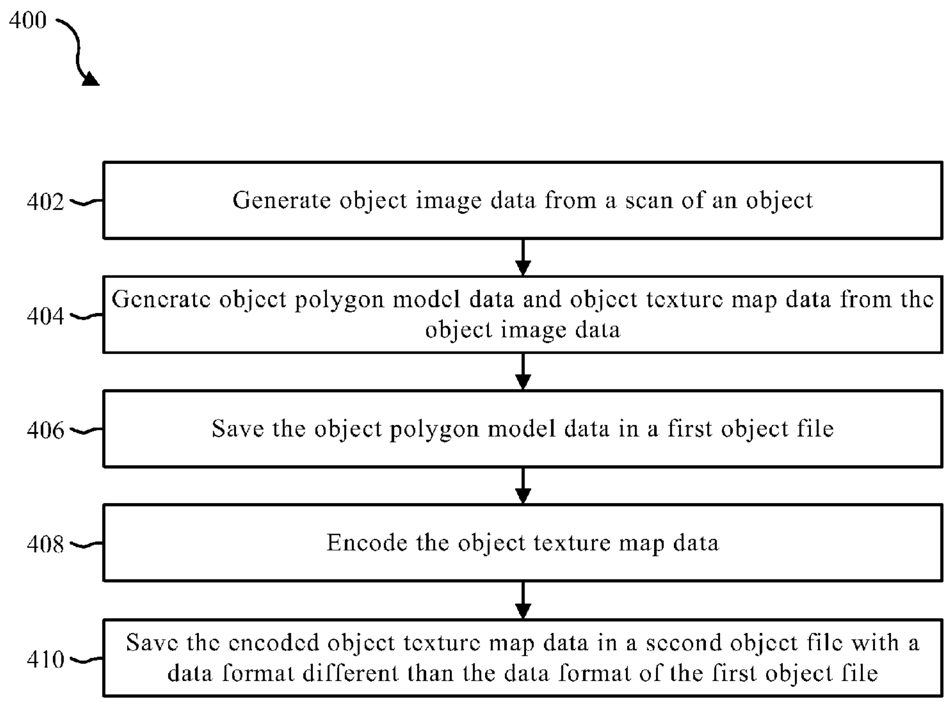

400
402
Generate object image data from a scan of an object
404
Generate object polygon model data and object texture map data from the object image data
406
Save the object polygon model data in a first object file
408
Encode the object texture map data
410
Save the encoded object texture map data in a second object file with a data format different than the data format of the first object file

FIG. 4

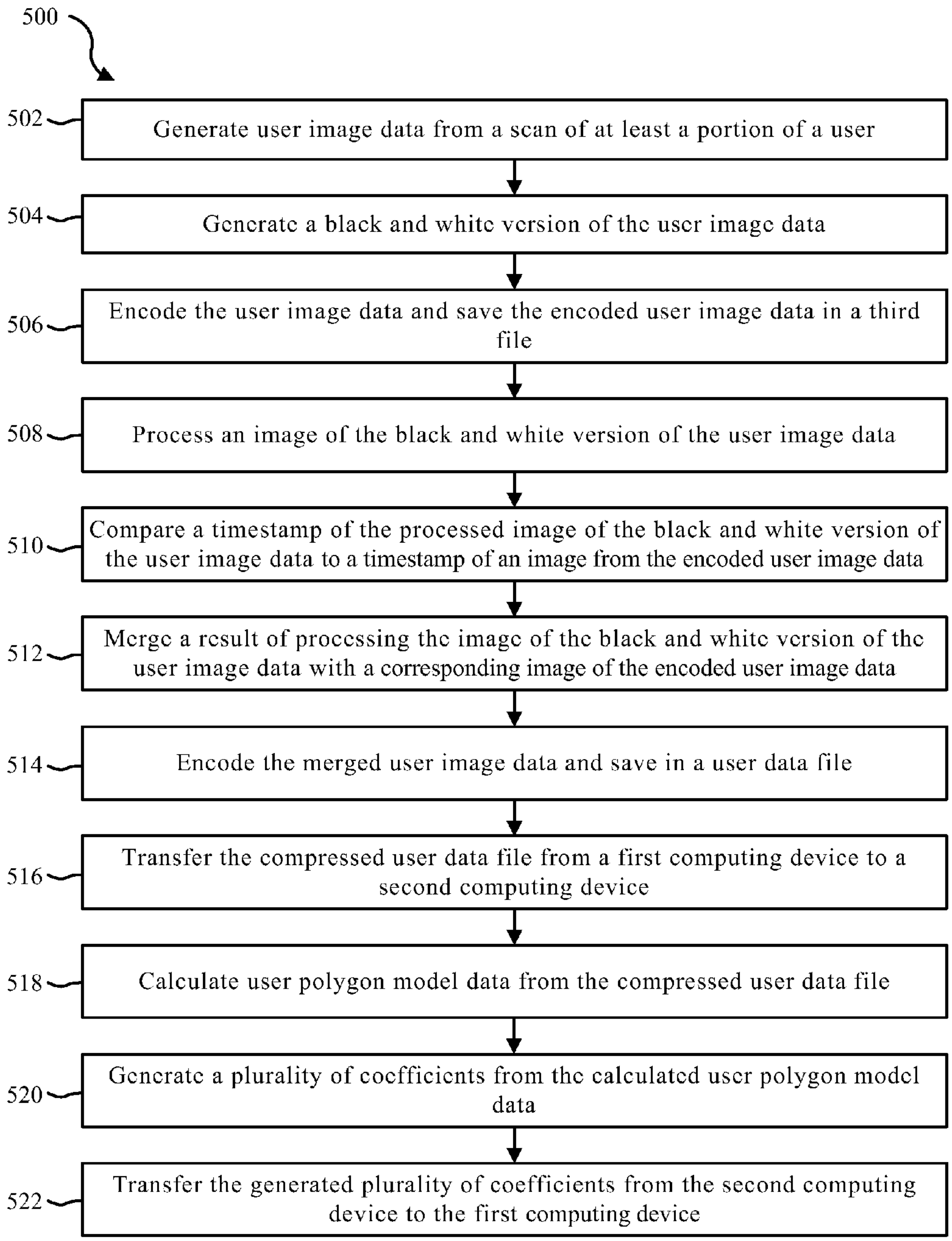

500
502
Generate user image data from a scan of at least a portion of a user
504
Generate a black and white version of the user image data
506
Encode the user image data and save the encoded user image data in a third file
508
Process an image of the black and white version of the user image data
510
Compare a timestamp of the processed image of the black and white version of the user image data to a timestamp of an image from the encoded user image data
512
Merge a result of processing the image of the black and white version of the user image data with a corresponding image of the encoded user image data
514
Encode the merged user image data and save in a user data file
516
Transfer the compressed user data file from a first computing device to a second computing device
518
Calculate user polygon model data from the compressed user data file
520
Generate a plurality of coefficients from the calculated user polygon model data
522
Transfer the generated plurality of coefficients from the second computing device to the first computing device

FIG. 5

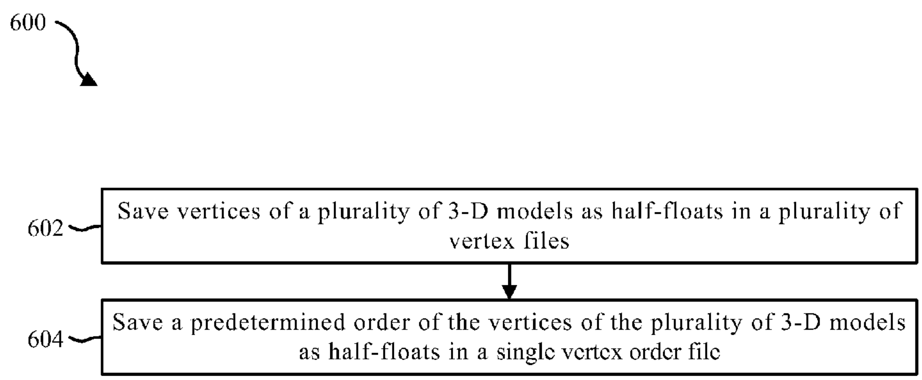

600
602
Save vertices of a plurality of 3-D models as half-floats in a plurality of vertex files
604
Save a predetermined order of the vertices of the plurality of 3-D models as half-floats in a single vertex order file

FIG. 6

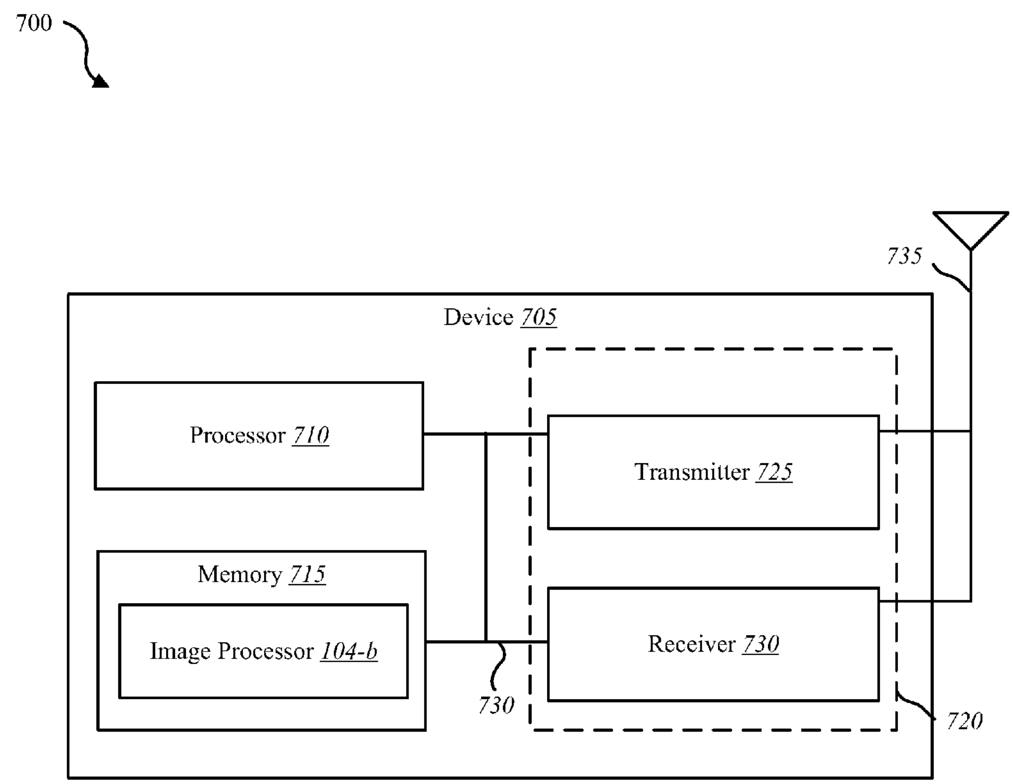
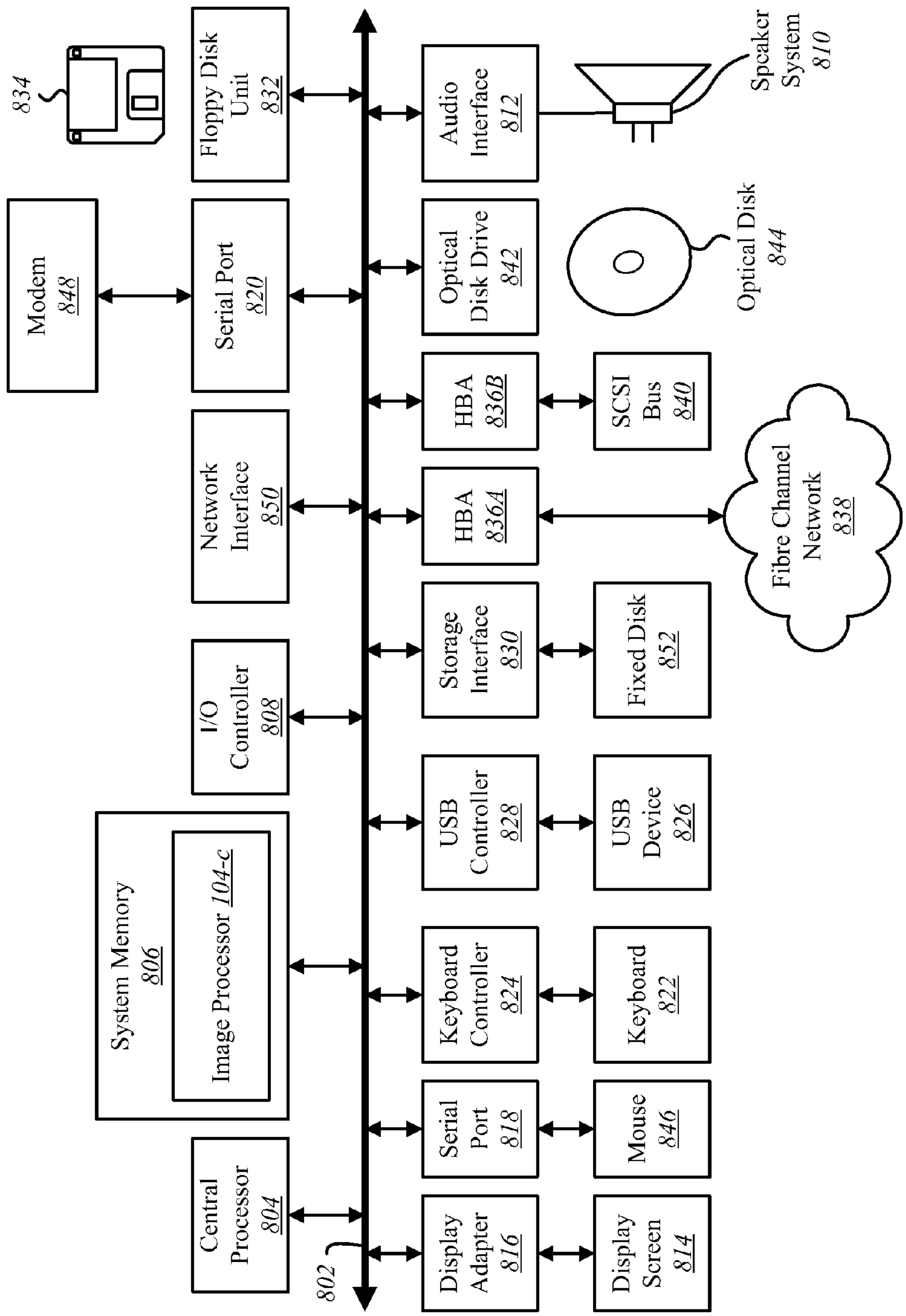

700
735
Device 705
Processor 710
Transmitter 725
Memory 715
Image Processor 104-b
Receiver 730
730
720

FIG. 7



834
Floppy Disk Unit 832
Modem 848
Serial Port 820
Network Interface 850
I/O Controller 808
System Memory 806
Image Processor 104-c
Central Processor 804
802
Audio Interface 812
Speaker System 810
Optical Disk Drive 842
Optical Disk 844
HBA 836B
SCSI Bus 840
HBA 836A
Fibre Channel Network 838
Storage Interface 830
Fixed Disk 852
USB Controller 828
USB Device 826
Keyboard Controller 824
Keyboard 822
Serial Port 818
Mouse 846
Display Adapter 816
Display Screen 814

FIG. 8

SYSTEMS AND METHODS FOR EFFICIENTLY PROCESSING VIRTUAL 3-D DATA

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/650,983, entitled SYSTEMS AND METHODS TO VIRTUALLY TRY-ON PRODUCTS, filed on May 23, 2012; and U.S. Provisional Application No. 61/735,951, entitled SYSTEMS AND METHODS TO VIRTUALLY TRY-ON PRODUCTS, filed on Dec. 11, 2012, which is incorporated herein in its entirety by this reference.

BACKGROUND

The use of computer systems and computer-related technologies continues to increase at a rapid pace. This increased use of computer systems has influenced the advances made to computer-related technologies. Indeed, computer systems have increasingly become an integral part of the business world and the activities of individual consumers. For example, computers have opened up an entire industry of internet shopping. In many ways, online shopping has changed the way consumers purchase products. For example, a consumer may want to know what they will look like in and/or with a product on the screen of their computer in a virtual sense. A virtual three-dimensional (3-D) scene may be rendered to improve the online shopping experience. Rendering a 3-D scene may involve processing relatively large amounts of data and computationally complex algorithms. Thus, current systems may introduce considerable delays processing a virtual 3-D scene.

SUMMARY

According to at least one embodiment, a computer-implemented method for processing virtual 3-D data efficiently is described. An object image data may be generated from a scan of an object. Object polygon model data and object texture map data may be generated from the object image data. The object polygon model data may be saved in a first object file. The object texture map data may be encoded. The encoded object texture map data may be saved in a second object file. The data format of the second object file may be different than the data format of the first object file.

In one embodiment, user image data may be generated from a scan of at least a portion of a user. A black and white version of the user image data may be created. The user image data may be encoded and the encoded user image data may be saved in a third file. An image of the black and white version of the user image data may be processed. A timestamp of the processed image of the black and white version of the user image data may be compared to a timestamp of an image from the encoded user image data. A result of processing the image of the black and white version of the user image data may be merged with a corresponding image of the encoded user image data. The merged user image data may be encoded and saved in a user data file. The encoded user data file may be transferred from a first computing device to a second computing device. User polygon model data may be calculated from the encoded user data file. A plurality of coefficients are generated from the calculated user polygon model data. In some embodiments, the coefficients are generated on the first computing device. The generated plurality of coefficients are transferred from the second computing device to the first computing device. On the first computing device, a morphable model of the user may be generated from the plurality of coefficients. The morphable model may be generated using a plurality of 3-D models. Vertices of the plurality of 3-D models may be saved as half-floats in a plurality of vertex files. A predetermined order of the vertices of the plurality of 3-D models may be saved as half-floats in a single vertex order file. In some embodiments, the first object file includes a binary-encoded file. The second object file and the encoded user data file include compressed video files.

A computing device configured to process virtual 3-D data efficiently is also described. The device may include a processor and memory in electronic communication with the processor. The memory may store instructions that are executable by the processor to generate object image data from a scan of an object, generate object polygon model data and object texture map data from the object image data, and save the object polygon model data in a first object file. Additionally, the instructions may be executable by the processor to encode the object texture map data and save the encoded object texture map data in a second object file with a data format different than the data format of the first object file.

A computer-program product to process virtual 3-D data efficiently is also described. The computer-program product may include a non-transitory computer-readable medium that stores instructions. The instructions may be executable by a processor to generate object image data from a scan of an object, generate object polygon model data and object texture map data from the object image data, and save the object polygon model data in a first object file. Additionally, the instructions may be executable by the processor to encode the object texture map data and save the encoded object texture map data in a second object file with a data format different than the data format of the first object file.

Features from any of the above-mentioned embodiments may be used in combination with one another in accordance with the general principles described herein. These and other embodiments, features, and advantages will be more fully understood upon reading the following detailed description in conjunction with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a number of exemplary embodiments and are a part of the specification. Together with the following description, these drawings demonstrate and explain various principles of the instant disclosure.

FIG. **1** is a block diagram illustrating one embodiment of an environment in which the present systems and methods may be implemented;

FIG. **2** is a block diagram illustrating another embodiment of an environment in which the present systems and methods may be implemented;

FIG. **3** is a block diagram illustrating one example of an image processor;

FIG. **4** is a flow diagram illustrating one embodiment of a method to process virtual 3-D data efficiently;

FIG. **5** is a flow diagram illustrating one embodiment of a method to process user image data;

FIG. **6** is a flow diagram illustrating one embodiment of a method to store polygon mesh vertices;

FIG. **7** depicts a block diagram of a computer system suitable for implementing the present systems and methods;

FIG. **8** depicts a block diagram of a computer system suitable for implementing the present systems and methods.

While the embodiments described herein are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, the exemplary embodiments described herein are not intended to be limited to the particular forms disclosed. Rather, the instant disclosure covers all modifications, equivalents, and alternatives falling within the scope of the appended claims.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The systems and methods described herein relate to the virtually tying-on of products. Three-dimensional (3-D) computer graphics are graphics that use a 3-D representation of geometric data that is stored in the computer for the purposes of performing calculations and rendering 2-D images. Such images may be stored for viewing later or displayed in real-time. A 3-D space may include a mathematical representation of a 3-D surface of an object. A 3-D model may be contained within a graphical data file. A 3-D model may represent a 3-D object using a collection of points in 3-D space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. Being a collection of data (points and other information), 3-D models may be created by hand, algorithmically (procedural modeling), or scanned such as with a laser scanner. A 3-D model may be displayed visually as a two-dimensional image through a process called 3-D rendering, or used in non-graphical computer simulations and calculations. In some cases, the 3-D model may be physically created using a 3-D printing device.

A virtual 3-D space may include a depiction of 3-D objects. For example, the virtual 3-D space may include a 3-D model of a user's face and a polygon mesh of a pair of glasses. The 3-D polygon mesh of the pair of glasses may be placed on the user to create a 3-D virtual depiction of the user wearing a properly scaled pair of glasses. Rendering a viewpoint of the 3-D scene may include processing, storing, and transferring over one or more networks relatively large amounts of data. The present system describes one or more embodiments of efficiently processing, storing, and transferring virtual 3-D data. Although many of the examples used herein describe the virtual try-on of glasses, it is understood that the systems and methods described herein may be used to virtually try-on a wide variety of products. Examples of such products may include glasses, clothing, footwear, jewelry, accessories, hair styles, etc.

FIG. **1** is a block diagram illustrating one embodiment of an environment **100** in which the present systems and methods may be implemented. In some embodiments, the systems and methods described herein may be performed on a single device (e.g., device **102**). For example, an image processor **104** may be located on the device **102**. Examples of devices **102** include mobile devices, smart phones, personal computing devices, computers, servers, etc.

In some configurations, a device **102** may include an image processor **104**, a camera **106**, and a display **108**. In one example, the device **102** may be coupled to a database **110**. In one embodiment, the database **110** may be internal to the device **102**. In another embodiment, the database **110** may be external to the device **102**. In some configurations, the database **110** may include polygon model data **112** and texture map data **114**.

In one embodiment, the image processor **104** may enable an efficient processing of virtual 3-D data to allow a user to virtually try-on a pair of glasses in a timely and data-efficient manner. In some configurations, the image processor **104** may obtain multiple images of a user. For example, the image processor **104** may capture multiple images of a user via the camera **106**. For instance, the image processor **104** may capture a video (e.g., a **5** second video) via the camera **106**. In some configurations, the image processor **104** may generate polygon model data **112** and texture map data **114** to generate a 3-D representation of a user. For example, the polygon model data **112** may include vertex coordinates of a polygon model of the user's head. In some embodiments, the image processor **104** may use color information from the pixels of multiple images of the user to create a texture map of the user. In some configurations, the image processor **104** may generate and/or obtain a 3-D representation of a product. For example, the polygon model data **112** and texture map data **114** may include a 3-D model of a pair of glasses. In some embodiments, the polygon model data **112** may include a polygon model of an object. In some configurations, the texture map data **114** may define a visual aspect (e.g., pixel information) of the 3-D model of the object such as color, texture, shadow, or transparency.

In some configurations, the image processor **104** may generate a virtual try-on image by efficiently processing, storing, and transferring at least a portion of a virtual 3-D space that contains a 3-D model of a user and a 3-D model of a product. In some configurations, the image processor **104** may output the virtual try-on image to the display **108** to be displayed to the user. In some embodiments, the image processor **104** may store the polygon model data **112** in a first object file and store the texture map data **114** in a second object file. In some configurations, the data format of the second object file may be different than the data format of the first object file. For example, the first object file may include a binary-encoded file format, and the second object file may include a compressed video file format.

FIG. **2** is a block diagram illustrating another embodiment of an environment **200** in which the present systems and methods may be implemented. In some embodiments, a device **102**-*a* may communicate with a server **206** via a network **204**. Examples of networks **204** include, local area networks (LAN), wide area networks (WAN), virtual private networks (VPN), wireless networks (using 802.11, for example), cellular networks (using 3G and/or LTE, for example), etc. In some configurations, the network **204** may include the internet. In some configurations, the device **102**-*a* may be one example of the device **102** illustrated in FIG. **1**. For example, the device **102**-*a* may include the camera **106**, the display **108**, and an application **202**. It is noted that in some embodiments, the device **102**-*a* may not include an image processor **104**. In some embodiments, both a device **102**-*a* and a server **206** may include an image processor **104** where at least a portion of the functions of the image processor **104** are performed separately and/or concurrently on both a device **102**-*a* and a server **206**.

In some embodiments, the server **206** may include the image processor **104** and may be coupled to the database **110**. For example, the image processor **104** may access the polygon model data **112** and the texture map data **114** in the database **110** via the server **206**. The database **110** may be internal or external to the server **206**.

In some configurations, the application **202** may capture multiple images via the camera **106**. For example, the application **202** may use the camera **106** to capture a video. Upon capturing the multiple images, the application **202** may process the multiple images to generate result data. In some embodiments, the application **202** may transmit the multiple images to the server **206**. Additionally, or alternatively, the application **202** may transmit to the server **206** the result data or at least one file associated with the result data.

In some configurations, the image processor **104** may efficiently process multiple images of a user to generate a 3-D model of the user. In some configurations, the image processor **104** may process a scan of an object to create a 3-D polygon model of the object. The image processor **104** may render a 3-D space that includes the 3-D model of the user and the 3-D polygon model of the object to render a virtual try-on 2-D image of the object and the user. The application **202** may output the rendered virtual try-on image to the display **208** to be displayed to the user.

FIG. **3** is a block diagram illustrating one example of an image processor **104**-*a*. As depicted, the image processor **104**-*a* may include a scanning module **302**, a polygon mesh module **304**, a texture mapping module **306**, a storage module **308**, an encoding module **310**, a comparison module **312**, and a coefficient generation module **314**.

In one embodiment, the scanning module **302** may generate object image data from a scan of an object. For example, a pair of glasses may be scanned. The scanning module **302** may generate object image data from the scan of a pair of glasses. Additionally, or alternatively, the scanning module **302** may generate user image data from a scan of at least a portion of a user. The polygon mesh module **304** may generate object polygon model data from the object image data. For example, the polygon mesh module **304** may generate multiple vertices of polygons to define the surface structure of a scanned object in a virtual 3-D space. The texture mapping module **306** may generate object texture map data from the object image data. For example, the texture mapping module **306** may generate a shadow texture map, a transparency texture map, and/or a color texture map of a scanned object.

In one embodiment, the storage module **308** may save the object polygon model data in a first object file and save the object texture map data in a second object file. The data format of the second file format may be different than the data format of the first object file. For example, the storage module **308** may store the object polygon model data in polygon model data **112** and the object texture map in texture map data **114** in database **110**. In some configurations, the storage module **308** may save the object polygon model data in a binary-encoded file format and save the object texture map in a compressed video file format.

In one embodiment, the encoding module **310** may encode the object texture map data. For example, the encoding module **310** may use a codec to encode the object texture map data. Examples of codecs include MPEG-1, MPEG-2, MPEG-4, H.264, AVI, and the like. Encoding data using a codec may include data compression. In some configurations, the encoding module **310** may encode the user image data. The storage module **308** may save the encoded object texture map data in the second file. The storage module **308** may save the encoded user image data in a third file. Thus, in some embodiments, the storage module **308** may save the object polygon model data in a first file, the encoded object texture map data in a second file, and the encoded user image data in a third file. For example, in a first scan, the scanning module **302** may capture a scan of a pair of glasses. From the scanned pair of glasses, the polygon mesh module **304** may generate object polygon model data and the texture mapping module **306** may generate object texture map data. The encoding module **310** may encode the object texture map data of the scanned pair of glasses using a video codec. The storage module **308** may store the encoded object texture map data in the texture map data **114** in the database **110**. The storage module **308** may store the object polygon model data in the polygon model data **112** in the database **110**. In a second scan, the scanning module **302** may capture a scan of a user's face. The scan of the user's face may include multiple reference viewpoints of the user's face. For instance, the scan of the user's face may include a panning of the user's face from ear to ear. As described above, the encoding module **310** may encode the image data from the scan of the user to efficiently process the user image data.

In some embodiments, the image processor **104**-*a* may create a black and white version of the user image data. For example, the scanning module **302** may capture user image data from a scan of the user in full color. To process the image data from the scan of the user more efficiently and in a more timely fashion, the image processor **104**-*a* may create a black and white version of the full-color user image data. The encoding module **310** may encode the color version of the scan of the user. In some configurations, the image processor **104**-*a* may process an image of the black and white version of the user image data. For example, the image processor **104**-*a* may calculate the camera viewing angle from each captured image of the user. Upon processing a black and white version of an image from the user image data, the comparison module **312** may compare a timestamp of the processed image of the black and white version of the user image data to a timestamp of an image from the encoded full-color user image data. Upon determining a match between the black and white image and full-color image, the image processor **104**-*a* may merge a result of processing the image of the black and white version of the user image data with a corresponding image of the full-color user image data. In some configurations, the encoding module **310** may encode the merged user image data using a video codec. The storage module **308** may store the encoded merged user image data into a user data file in a compressed video file format. Encoding the user data file in a compressed video file format may allow the user data file to be transferred over a computer network (e.g., network **204**) more efficiently than transferring the original, un-encoded data from the scan of the user. The storage module **308** may store the user image data in the database **110**. Thus, the image processor **104**-*a* may efficiently process the scan of the user in black and white and incorporate the result of processing the black and white version of the scan of the user with the full-color version of the scan of the user, thus saving computing resources and reducing the time a user waits before being able to view a rendered 3-D scene (e.g., a virtual depiction of the user wearing a virtual pair of glasses) on the display **108** of the device **102**.

In some embodiments, the polygon mesh module **304** may calculate user polygon model data from the scan of a user. As described above, the results of the scan of the user may be encoded by the encoding module **310**. The encoding module **310** may use a codec to encode the user image data. In some embodiments, the image processor **104**-*a* may transmit the encoded user data file to a server **206**. The server **206** may process the encoded user data file. Additionally, or alternatively, the user data file may be processed on the device **102**. In some embodiments, the polygon mesh module **304** may calculate user polygon model data from the encoded user data file. In one embodiment, the coefficient generation module **314** may generate a plurality of coefficients from the calculated user polygon model data. For example, the database **110** may include a morphable model to depict a user's head in a 3-D space. The morphable model may be configured to morph into the calculated shape of the user's head determined from the scan of the user. In some embodiments, the shape of the morphable model may be determined from the linear combination of a predetermined number of coefficients.

Thus, instead of transferring the entire set of calculated user polygon model data from the server **206** to the device **102**-*a*, in some configurations, the server **206** sends a predetermined number of coefficients to the device **102**-*a*. The device **102**-*a*, via the polygon mesh module **304**, may generate a polygon model of the user's head from the predetermined number of coefficients sent from the server **206**, thus conserving computing resources, limiting computing overhead, and reducing network traffic.

In some configurations, the storage module **308** may save vertices of a plurality of 3-D models (e.g., the morphable model) as half-floats in a plurality of vertex files. The storage module may save a predetermined order of the vertices of the plurality of 3-D models as half-floats in a single vertex order file.

FIG. **4** is a flow diagram illustrating one embodiment of a method to process virtual 3-D data efficiently. In some configurations, the method **400** may be implemented by the image processor **104** illustrated in FIGS. **1**, **2**, and/or **3**. In some configurations, the method **400** may be implemented by the application **202** illustrated in FIG. **2**.

At block **402**, an object image data may be generated from a scan of an object. At block **404**, object polygon model data and object texture map data may be generated from the object image data. For example, polygon model data and texture map data may be generated from a scanned pair of glasses.

At block **406**, the object polygon model data may be stored in a first object file. At block **408**, the object texture map data may be encoded. At block **410**, the encoded object texture map data may be stored in a second object file with a data format different than the data format of the first object file. In some embodiments, the first object file is saved in a binary-encoded file format and the second object file is saved in a compressed video file format.

FIG. **5** is a flow diagram illustrating one embodiment of a method to process user image data. In some configurations, the method **500** may be implemented by the image processor **104** illustrated in FIGS. **1**, **2**, and/or **3**. In some configurations, the method **500** may be implemented by the application **202** illustrated in FIG. **2**.

At block **502**, user image data may be generated from a scan of at least a portion of a user. For example, a user's face may be scanned using the video camera on a tablet computing device. At block **504**, a black and white version of the user image data may be generated. For example, a video scan of a user's face from ear to ear may be captured in color. A black and white copy of the color version of the scan may be generated for efficient processing of the scanned image data.

At block **506**, the user image data may be encoded and the encoded user image data may be saved in a third file. For example, the scan of an object may produce a first file storing the polygon model data of the object and a second file storing the texture map data of the object. A scan of a user may produce a third file.

At block **508**, an image of the black and white version of the user image data may be processed. Processing a black and white copy of the full-color scan of the user conserves computing resources by reducing computing overhead. At block **510**, a timestamp of the processed image of the black and white version of the user image data may be compared to a timestamp of an image from the full-color encoded user image data. Upon determining a match, a result of processing the image of the black and white version of the user image data may be merged with a corresponding image of the encoded user image data.

At block **514**, the merged user image data may be encoded and saved in a user data file. At block **516**, the encoded user data file may be transferred from a first computing device to a second computing device. For example, the encoded user data file may be transferred over the network **204** from a device **102** to a server **206** for further processing at the server **206**. Alternatively, in some embodiments, the encoded user data file remains on the device **102** and is processed at the device **102**.

At block **518**, user polygon model data may be calculated from the encoded user data file. As explained above, in some embodiments, the polygon model data may be calculated at the server **206**. Alternatively, the polygon model data may be calculated at the device **102**.

At block **520**, a plurality of coefficients may be generated from the calculated user polygon model data. At block **522**, the generated plurality of coefficients may be transferred from the second computing device to the first computing device. For example, the generated plurality of coefficients may be transferred from the server **206** to a device **102**. From the received plurality of coefficients, the polygon mesh module **304** may be configured to generate a polygon mesh model of the user. Alternatively, the polygon mesh module **304** generates a polygon mesh model of the user from the scan of the user.

FIG. **6** is a flow diagram illustrating one embodiment of a method **600** to store polygon mesh vertices. In some configurations, the method **600** may be implemented by the image processor **104** illustrated in FIGS. **1**, **2**, and/or **3**. In some configurations, the method **600** may be implemented by the application **202** illustrated in FIG. **2**.

At block **602**, vertices of a plurality of 3-D models may be stored as half-floats in a plurality of vertex files. For example, vertices of a 3-D model of a pair of glasses and a 3-D model of a user may be stored as half-floats. Additionally, or alternatively, the database **110** may include a morphable model. The morphable model may be configured to morph into the calculated shape of the user's head determined from the scan of the user. Thus, in some configurations, vertices of the morphable model may be saved as half-floats in a plurality of vertex files, where the vertices of the morphable model have a certain order. At block **604**, a predetermined order of the vertices of the plurality of 3-D models (e.g., morphable model) may be stored as half-floats in a single vertex order file.

FIG. **7** depicts a block diagram of a computer system **700** suitable for implementing the present systems and methods. In one embodiment, the computer system **700** may include a mobile device **705**. The mobile device **705** may be an example of a device **102** depicted in FIGS. **1**, **2**, and/or **3**. As depicted, the mobile device **705** includes a bus **730** which interconnects major subsystems of mobile device **705**, such as a central processor **710**, a system memory **715** (typically RAM, but which may also include ROM, flash RAM, or the like), and a transceiver **720** that includes a transmitter **730**, a receiver **735**, and an antenna **740**.

Bus **730** allows data communication between central processor **710** and system memory **715**, which may include read-only memory (ROM) or flash memory (neither shown), and random access memory (RAM) (not shown), as previously noted. The RAM is generally the main memory into which the operating system and application programs are loaded. The ROM or flash memory can contain, among other code, the Basic Input-Output system (BIOS) which controls basic hardware operation such as the interaction with peripheral components or devices. For example, the image processor **104**-*b* to implement the present systems and methods may be stored within the system memory **715**. The image processor **104**-*b* may be one example of the image processor **104** depicted in FIGS. **1**, **2**, and/or **3**. In some embodiments, the transmitter **725** may be configured to transfer the compressed user data file from the mobile device **705** to a second computing device (e.g., server **206**). In some configurations, the receiver **730** may be configured to receive the generated plurality of coefficients from the second computing device (e.g., server **206**) to the mobile device **705**.

Applications resident with mobile device **705** may be stored on and accessed via a non-transitory computer readable medium, such as a hard disk drive, an optical drive, or other storage medium. Additionally, applications can be in the form of electronic signals modulated in accordance with the application and data communication technology when accessed via a network.

FIG. **8** depicts a block diagram of a computer system **800** suitable for implementing the present systems and methods. The depicted computer system **800** may be one example of a server **206** depicted in FIG. **2**. Alternatively, the system **800** may be one example of a device **102** depicted in FIG. **1** or **2**, or the mobile device **705** depicted in FIG. **7**. Computer system **800** includes a bus **802** which interconnects major subsystems of computer system **800**, such as a central processor **804**, a system memory **806** (typically RAM, but which may also include ROM, flash RAM, or the like), an input/output controller **808**, an external audio device, such as a speaker system **810** via an audio output interface **812**, an external device, such as a display screen **814** via display adapter **816**, serial ports **818** and mouse **820**, a keyboard **822** (interfaced with a keyboard controller **824**), multiple USB devices **826** (interfaced with a USB controller **828**), a storage interface **830**, a host bus adapter (HBA) interface card **836**A operative to connect with a Fibre Channel network **838**, a host bus adapter (HBA) interface card **836**B operative to connect to a SCSI bus **840**, and an optical disk drive **842** operative to receive an optical disk **844**. Also included are a mouse **846** (or other point-and-click device, coupled to bus **802** via serial port **818**), a modem **848** (coupled to bus **802** via serial port **820**), and a network interface **850** (coupled directly to bus **802**).

Bus **802** allows data communication between central processor **804** and system memory **806**, which may include read-only memory (ROM) or flash memory (neither shown), and random access memory (RAM) (not shown), as previously noted. The RAM is generally the main memory into which the operating system and application programs are loaded. The ROM or flash memory can contain, among other code, the Basic Input-Output system (BIOS) which controls basic hardware operation such as the interaction with peripheral components or devices. For example, the image processor **104**-*c* to implement the present systems and methods may be stored within the system memory **806**. The image processor **104**-*c* may be one example of the image processor **104** depicted in FIGS. **1**, **2**, **3**, and/or **7**. Applications resident with computer system **800** are generally stored on and accessed via a non-transitory computer readable medium, such as a hard disk drive (e.g., fixed disk **852**), an optical drive (e.g., optical drive **842**), or other storage medium. Additionally, applications can be in the form of electronic signals modulated in accordance with the application and data communication technology when accessed via network modem **848** or interface **850**.

Storage interface **830**, as with the other storage interfaces of computer system **800**, can connect to a standard computer readable medium for storage and/or retrieval of information, such as a fixed disk drive **852**. Fixed disk drive **852** may be a part of computer system **800** or may be separate and accessed through other interface systems. Modem **848** may provide a direct connection to a remote server via a telephone link or to the Internet via an internet service provider (ISP). Network interface **850** may provide a direct connection to a remote server via a direct network link to the Internet via a POP (point of presence). Network interface **850** may provide such connection using wireless techniques, including digital cellular telephone connection, Cellular Digital Packet Data (CDPD) connection, digital satellite data connection or the like.

Many other devices or subsystems (not shown) may be connected in a similar manner (e.g., document scanners, digital cameras and so on). Conversely, all of the devices shown in FIG. **8** need not be present to practice the present systems and methods. The devices and subsystems can be interconnected in different ways from that shown in FIG. **8**. The operation of at least some of the computer system **800** such as that shown in FIG. **8** is readily known in the art and is not discussed in detail in this application. Code to implement the present disclosure can be stored in a non-transitory computer-readable medium such as one or more of system memory **806**, fixed disk **852**, or optical disk **844**. The operating system provided on computer system **800** may be MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, Linux®, or another known operating system.

Moreover, regarding the signals described herein, those skilled in the art will recognize that a signal can be directly transmitted from a first block to a second block, or a signal can be modified (e.g., amplified, attenuated, delayed, latched, buffered, inverted, filtered, or otherwise modified) between the blocks. Although the signals of the above described embodiment are characterized as transmitted from one block to the next, other embodiments of the present systems and methods may include modified signals in place of such directly transmitted signals as long as the informational and/or functional aspect of the signal is transmitted between blocks. To some extent, a signal input at a second block can be conceptualized as a second signal derived from a first signal output from a first block due to physical limitations of the circuitry involved (e.g., there will inevitably be some attenuation and delay). Therefore, as used herein, a second signal derived from a first signal includes the first signal or any modifications to the first signal, whether due to circuit limitations or due to passage through other circuit elements which do not change the informational and/or final functional aspect of the first signal.

While the foregoing disclosure sets forth various embodiments using specific block diagrams, flowcharts, and examples, each block diagram component, flowchart step, operation, and/or component described and/or illustrated herein may be implemented, individually and/or collectively, using a wide range of hardware, software, or firmware (or any combination thereof) configurations. In addition, any disclosure of components contained within other components should be considered exemplary in nature since many other architectures can be implemented to achieve the same functionality.

The process parameters and sequence of steps described and/or illustrated herein are given by way of example only and can be varied as desired. For example, while the steps illustrated and/or described herein may be shown or discussed in a particular order, these steps do not necessarily need to be performed in the order illustrated or discussed. The various exemplary methods described and/or illustrated herein may also omit one or more of the steps described or illustrated herein or include additional steps in addition to those disclosed.

Furthermore, while various embodiments have been described and/or illustrated herein in the context of fully functional computing systems, one or more of these exemplary embodiments may be distributed as a program product in a variety of forms, regardless of the particular type of computer-readable media used to actually carry out the distribution. The embodiments disclosed herein may also be implemented using software modules that perform certain tasks. These software modules may include script, batch, or other executable files that may be stored on a computer-readable storage medium or in a computing system. In some embodiments, these software modules may configure a computing system to perform one or more of the exemplary embodiments disclosed herein.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the present systems and methods and their practical applications, to thereby enable others skilled in the art to best utilize the present systems and methods and various embodiments with various modifications as may be suited to the particular use contemplated.

Unless otherwise noted, the terms “a” or “an,” as used in the specification and claims, are to be construed as meaning “at least one of.” In addition, for ease of use, the words “including” and “having,” as used in the specification and claims, are interchangeable with and have the same meaning as the word “comprising.” In addition, the term “based on” as used in the specification and the claims is to be construed as meaning “based at least upon.”

What is claimed is:

1. A computer-implemented method for processing virtual 3-D data efficiently, the method comprising:

generating, via a processor of a mobile computing device, user image data from a scan of a user, wherein the scan includes a plurality of images including a portion of a user, the scan being from a first area of the user to a second area of the user captured by relative movement between a camera of the mobile computing device and the portion of the user;

generating, via the processor, object polygon model data and object texture map data from the user image data;

saving, via the processor, the object polygon model data in a first object file;

encoding, via the processor, the object texture map data;

saving, via the processor, the encoded object texture map data in a second object file, wherein a data format of the second object file is different than a data format of the first object file;

encoding the user image data and saving the encoded user image data in a third file;

transferring the encoded user image data file from the mobile computing device to a second computing device;

calculating user polygon model data from the encoded user image data file and generating a plurality of coefficients from the calculated user polygon model data on the second computing device; and

transferring the generated plurality of coefficients from the second computing device to the mobile computing device.

2. The method of claim **1**, further comprising:

creating a black and white version of the user image data; and

processing an image of the black and white version of the user image data.

3. The method of claim **2**, further comprising:

comparing a timestamp of the processed image of the black and white version of the user image data to a timestamp of an image from the encoded user image data;

merging a result of processing the image of the black and white version of the user image data with a corresponding image of the encoded user image data; and

encoding the merged user image data and saving the encoded merged user image data into a user data file.

4. The method of claim **3**, wherein the first object file includes a binary-encoded file, and wherein the second object file and the encoded user data file include compressed video files.

5. The method of claim **1**, further comprising:

saving vertices of a plurality of 3-D models as half-floats in a plurality of vertex files.

6. The method of claim **5**, further comprising:

saving a predetermined order of the vertices of the plurality of 3-D models as half-floats in a single vertex order file.

7. A computing device configured to process virtual 3-D data efficiently, comprising:

a processor of a mobile computing device;

memory in electronic communication with the processor;

instructions stored in the memory, the instructions being executable by the processor to:

generate user image data from a scan of a user, wherein the scan includes a plurality of images including a portion of a user, the scan being from a first area of the user to a second area of the user captured by relative movement between a camera of the mobile computing device and the portion of the user;

generate object polygon model data and object texture map data from the user image data;

save the object polygon model data in a first object file;

encode the object texture map data; and save the encoded object texture map data in a second object file, wherein a data format of the second object file is different than a data format of the first object file;

encode the user image data and saving the encoded user image data in a third object file;

transfer the encoded user image data file from the mobile computing device to a remote computing device;

calculate user polygon model data from the encoded user image data file and generating a plurality of coefficients from the calculated user polygon model data on the remote computing device; and

transfer the generated plurality of coefficients from the remote computing device to the mobile computing device.

8. The computing device of claim **7**, wherein the instructions are executable by the processor to:

create a black and white version of the user image data; and

process an image of the black and white version of the user image data.

9. The computing device of claim **8**, wherein the instructions are executable by the processor to:

compare a timestamp of the processed image of the black and white version of the user image data to a timestamp of an image from the encoded user image data;

merge a result of processing the image of the black and white version of the user image data with a corresponding image of the encoded user image data; and

encode the merged user image data and save the encoded merged user image data into a user data file.

10. The computing device of claim 9, wherein the first object file includes a binary-encoded file, and wherein the second object file and the encoded user data file include compressed video files.

11. The computing device of claim 7, wherein the instructions are executable by the processor to:

save vertices of a plurality of 3-D models as half-floats in a plurality of vertex files.

12. The computing device of claim 7, wherein the instructions are executable by the processor to:

save a predetermined order of the vertices of the plurality of 3-D models as half-floats in a single vertex order file.

13. A computer-program product for processing virtual 3-D data efficiently, the computer-program product comprising a non-transitory computer-readable medium storing instructions thereon, the instructions being executable by a processor of a mobile computing device to:

generate user image data from a scan of a user, wherein the scan includes a plurality of images including a portion of a user, the scan being from a first area of the user to a second area of the user captured by relative movement between a camera of the mobile computing device and the portion of the user;

generate object polygon model data and object texture map data from the user image data;

save the object polygon model data in a first object file;

encode the object texture map data; and

save the encoded object texture map data in a second object file, wherein a data format of the second object file is different than a data format of the first object file;

encode the user image data and saving the encoded user image data in a third object file;

transfer the encoded user image data file from the computing device to a remote computing device;

calculate user polygon model data from the encoded user image data file and generating a plurality of coefficients from the calculated user polygon model data on the remote computing device; and

transfer the generated plurality of coefficients from the remote computing device to the first computing device.

14. The computer-program product of claim 13, wherein the instructions are executable by the processor to:

create a black and white version of the user image data;

process an image of the black and white version of the user image data;

compare a timestamp of the processed image of the black and white version of the user image data to a timestamp of an image from the encoded user image data;

merge a result of processing the image of the black and white version of the user image data with a corresponding image of the encoded user image data; and

encode the merged user image data and save the encoded merged user image data into a user data file.

15. The computer-implemented method of claim 1, further comprising:

generating, via the processor of the mobile computing device, a 3-D model of the user with the object polygon model data and the object texture map data;

receiving, via the processor of the mobile computing device, a 3-D model of a product; and

displaying, via the processor of the mobile computing device, the 3-D model of a product on the 3-D model of the user.

16. The computing device of claim 8, wherein the instructions are executable by the processor to:

generate a 3-D model of the user with the object polygon model data and the object texture map data;

receive a 3-D model of a product; and

display the 3-D model of a product on the 3-D model of the user.

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